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BROOKLYN BOTANIC GARDEN
LEAFLETS

SERIES XVI BROOKLYN, N. Y., APRIL 4, 1928 No. 1

THE STORY OF PLANT EVOLUTION

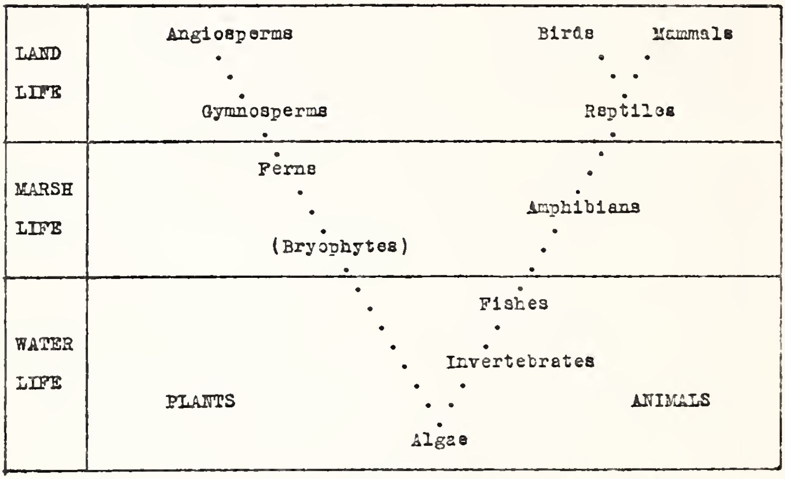
Evolution in Inorganic Nature. The importance of the principle of evolution has been confirmed by its extension to inorganic nature. A common origin of the elements was suggested first in chemistry by the significant facts of the periodic system. In the present century, in physics, the phenomena of radioactivity and the development of the theory of electrons have pointed in the same direction. But most important, in astronomy, the spectra of the stars form series, indicating gradual transition from large diffuse stars to small condensed ones. The recently increased evidence that the spiral nebulae are external galaxies rather than beginning individual stars vastly extends the problems of stellar evolution. It appears that the one hundred or one thousand million years of organic evolution are brief compared with the aeons of the histories of the stars.

Evidences of Organic Evolution. The most convincing evidence of changing organic life is that from fossils. These have supplied "missing links" in numerous groups of plants and animals. The most famous example is the first bird, *Archaeopteryx.* It had teeth, claws on the wings, and a vertebrate tail suggestive of reptiles. The fossils showing the ancestry of the horse have been called the "édition de luxe" of nature's book of evolution. Here almost every link is found between the modern horse and its small five-toed ancestor. The five-toed ancestry of the horse is suggested also by comparison with other animals, and especially by the life history of each individual, showing five toes in the embryo, as in other mammals. When fossils (paleontology), the comparison of living forms (comparative anatomy), and life histories (ontogeny) all point in one direction, the evidence is conclusive and universally accepted. In other cases the evidence is incomplete, and divergent views result as to the precise course of evolution.

Water, Marsh, and Land Life. Fossil evidence establishes the three main stages of organic evolution; water, marsh, and land life. These are the same for the plant and animal worlds. The Cambrian, first of the Paleozoic periods, shows exclusively water forms. Individual development often more or less recapitulates water ancestry.

The early stage of mosses, the protonema, is essentially an alga. The swimming sperms of ferns and cycads remind us of their former surroundings. The tadpole stage of a frog is essentially a fish. The mammals, including man, pass through a stage with gills plainly showing.

A tree has been called an organism for taking in sunshine. This statement applies equally to the entire world of green plants. The animal world is entirely dependent upon plants for its existence. And so, both worlds have developed side by side: the water animals from the beginning have fed on the algae; the cold blooded reptiles, on gymnosperms with comparatively little nourishment; the mammals, in general, on the more nutritious angiosperms. The lowest animals, are floating or stationary; food is absorbed from the sea. They differ very little from the lowest plants. Higher animals have movement; with an alimentary canal and circulation of blood, they carry, so to speak, a condensed ocean inside of themselves. Similarly the highest animals, warm-blooded, may be said to carry climate inside. More heat required more food, so the broad leaved angiosperms, with grasses and fruits, had to come before mammals and birds could develop.



COMPARATIVE DEVELOPMENT OF THE PLANT AND ANIMAL WORLDS

Life in the Water. Algae appear to be present in abundance among the earliest fossils. Their existence may be inferred also from the abundant animal life, which depended on them. In the Cambrian period all the chief phyla of animals were present, with the important exception of vertebrates.

Of living plants the blue-green and green algae include the simplest forms. They live in water or in wet places. Bacteria are another probably very ancient group. The brown and the red algae or seaweeds are more specialized and grow chiefly in salt water.

From Water to Moist Land. Many fossils of animals are suggestive of the passage from water to land. Water plants, however, having no hard parts, are identified with difficulty in the fossil state, or not at all. Land plants of four or five groups—Rhynia, tree clubmosses, horsetails, ferns, and Cordaites—appear in the Devonian.

For ideas as to their ancestry we must depend chiefly on the form and life histories of living plants. Although Bryophytes are hardly known from the Paleozoic, by several of their characters they suggest what we may believe to have been among the earliest land plants. Their archegonia, small bottle-shaped structures, enclose and protect the egg-cells, enabling them to live on moist land. When fertilized, the egg-cells develop into special structures called sporogonia, which produce spores.

Lichens are fungi growing in close association with algae, and may be a very ancient group, adapted to growth on rocks.

From Rhizoids to Roots. Water plants need no special organs to take in moisture, for it surrounds them. Many algae have rhizoid-like structures, which serve to hold them fast to supports, an important function on a stormy shore. Liverworts and mosses have rhizoids, but no roots. Such plants never grow to any considerable size; they can live for the most part only in moist places. Liverworts like *Riccia* grow flat on the soil, other liverworts and mosses grow to a height of a few inches. Among the earliest fossil land plants are the recently discovered *Rhynia* and *Psilophyton.* These are vascular plants with no roots, no differentiation of stem and leaf, and with terminal naked spores, suggesting the peculiar tropical plant *Psilotum.*

True roots have root hairs and conducting tissue to carry water and solutions. They exist in clubmosses, ferns, and higher plants. Water conducting tissues are well developed in the paleozoic fossils such as tree-clubmosses (*Lepidodendron* and *Sigillaria*), tree horsetails (*Calamites*), ferns and tree ferns, and the early gymnosperm *Cordaites.*

In clubmosses and the higher plants, the sexual generation, called the prothallium, is comparatively inconspicuous. The sperms of clubmosses have two cilia as in the bryophytes; those of horsetails, ferns, and cycads have many cilia.

From Small Leaves to Large Leaves. The clubmosses, horsetails, and other so-called fern allies have the common character of small leaves. It is not merely that they are small such as some flowering plant leaves often are, but they have no "foliar gap." Where the fibro-vascular bundle branches off it does so directly. In the ferns and higher plants, where the leaf-bundle separates it leaves a gap in the central cylinder. It is as if a portion of the central cylinder were given up to make a large leaf.

With larger leaves there is greater capacity for chlorophyll making. There are usually numerous spore-cases on the under side of some of the leaves, while the club mosses have a single spore-case on the upper side.

In the water-ferns, and also in *Selaginella* and in the quillworts, there are two sizes of sports.

From Spores to Seeds. In the ferns, mosses, and liverworts, the spores usually fall to the ground. These can germinate into new plants which bear eggs and sperms. Finally an egg and a sperm unite. This is called fertilization, and from the fertilized egg another plant develops which bears the spores.

In the seed-bearing plants there are always two sizes of spores. In these, however, the large spore remains in its place on the parent plant, where it germinates. The small spore is brought to it usually by wind or insects; it germinates and fertilizes the egg developed within the large spore. This and accompanying processes result in the production of a seed which is essentially a dormant, small plant with surrounding structures. More or less protected by coverings, it is capable of remaining in a dormant condition for some time; and in this respect is superior in a reproductive capacity to the small one-celled spores.

The lowest seed-bearing plants, such as cycads and ginkgo, resemble the algae, mosses, and ferns, in having swimming sperms, thus needing water for fertilization. The conifers and angiosperms have sperms without swimming cilia, as if more fully adapted to land life.

From Cones to Flowers. The lower seed-bearing plants, or gymnosperms, have naked seeds. In the angiosperms or flowering plants the seeds are enclosed in an ovary, which develops into a fruit.

The angiosperms form two main groups. First, the dicotyledons which are nearer to the gymnosperms. They have two seed leaves, and their foliage leaves are usually broad and netted-veined. The floral parts are mostly in four's or five's. Trees and shrubs have often more primitive characters than herbaceous plants. The evolution of flowers occurs along many lines, from parts (sepals, petals, stamens and carpels) all separate, to the condition where they are more or less united. Other developments are from regular to irregular flowers, that is, toward increasing adaptation to insect pollination. In general, herbaceous plants and those with united petals appear to be the most recently evolved dicotyledons. The Composite family is by many considered the most advanced.

The other group, the monocotyledons, appear to be a side line. They are for the most part herbaceous, with one seed leaf; the foliage leaves are mostly parallel-veined, and the floral parts usually in three's. Of these, the orchids are the most highly specialized.

Alfred Gundersen.

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XVI BROOKLYN, N. Y., APRIL 18, 1928 NOS. 2 AND 3

HOW BACTERIA ARE STUDIED IN HIGH SCHOOL SCIENCE CLASSES

The most useful living things in the world are not the grains, the fruits, or any of the food plants or animals; not the forest trees, nor any kinds which one would ordinarily think of first in this connection. Fundamentally the most useful living things are bacteria. If you will think for a moment of their activities in the soil, of their relation to the life and growth of all larger plants, and of the essential part they play in the chemical circulation of the vitally necessary elements—nitrogen, sulphur, and carbon—you will realize how basic bacteria are to all life. In a lesser way, they are important in the production of milk products, leather, and scores of other useful materials.

Both in their capacity as useful organisms, and as harmful disease germs, bacteria come in for careful study in any well-planned high school courses in hygiene, biology, or general science. At the present time, one or more of these courses is being taken by most of the one hundred and twenty five thousand New York City high school pupils, and by many additional thousands in the junior high schools.

For the experimental study of bacteria, the chief kind of apparatus is the *Petri* dish (originally devised in 1887 by R. J. Petri in a Berlin laboratory). The Petri dish in reality is *two* dishes, each one being a shallow glass saucer with a perpendicular rim, one fitting rather snugly as a dust-proof cover over the other. For the culture of bacteria in the petri dish, a gelatinous material is used, known as agar, or agar-agar, prepared from several Oriental seaweeds, which are classed together under this native name. To this agar, which serves the purpose of a matrix or substance for the bacteria to grow upon, are added one or more kinds of food, such as beef broth, prune juice, sugars, peptone, etc., which furnish the nourishment for the tiny plants.

The preparation of these petri dishes for class use, as one can readily understand, involves great care, and special apparatus is necessary which high schools usually do not possess. As a result, it has come to be accepted that the high schools may ask the cooperation of a few of the institutions where bacteriological apparatus and technic are part of the routine equipment. The Brooklyn Botanic Garden fills annually thousands of petri dishes with agar for the schools of Greater New York. With such dishes it is possible, even in elementary classes, to discover experimentally the answers to numerous interesting and important questions regarding the relations of bacteria to health. For example:

"How can one test any substance for the presence of bacteria?"

"Where do bacteria occur in nature? Are they abundant on the skin, the hair, the teeth, etc.?"

"What effect do antiseptics have on bacteria?"

"Are there many in the air? Are there more in the subway than in the school room? More in the streets than in the parks?"

"How far does a sick person cough his germs?"

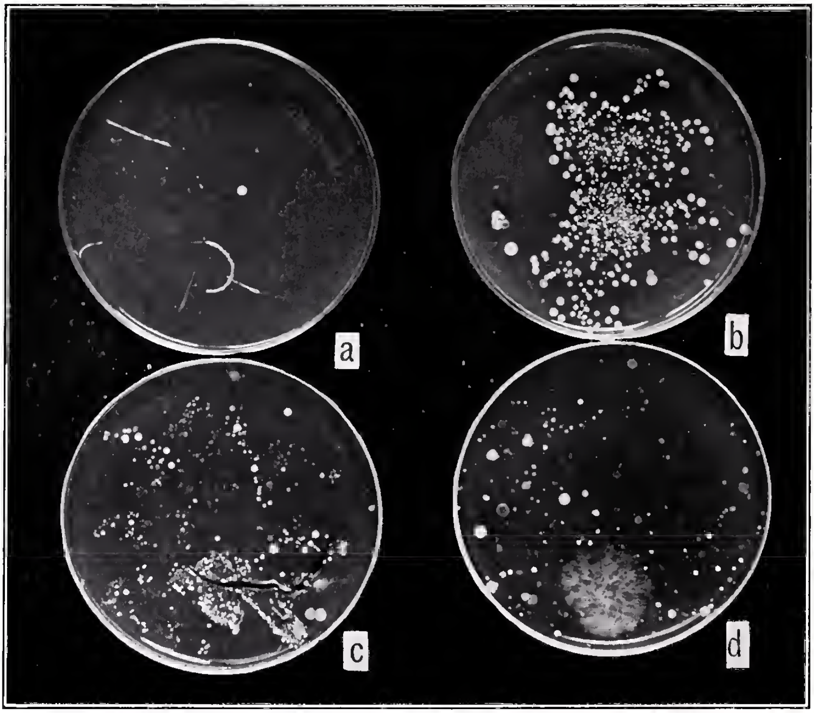


FIGURE 1. Petri dishes exposed under various conditions. *a,* Bacterial colonies developing on human hair planted in the nutrient agar. *b,* colonies from scrapings from a piece of chalk. *c,* from finger tips of pupils. *d,* from dust.

How Can One Test Any Substance for the Presence of Bacteria?

To begin with, the closed petri dish, with its content of clear, brownish, gelatinous, nutrient agar, constitutes a "virgin soil," on which most kinds of bacteria will grow readily. Planting consists merely in exposing the agar surface to whatever is to be tested, taking pains to guard against the entrance of bacteria from any other sources. Are there bacteria on the finger-tips? Tilt the cover just enough to allow you to poke in your finger and touch the moist surface. Then put the dish away in a warm place for a few days and watch for results.

Bacteria are so small and there are so many kinds which look alike under the microscope that it would be useless to submit the fingers to a direct microscopic examination. However, despite their small size (some are only one twenty-five thousandth of an inch long) they possess a capacity for very rapid reproduction. Under the most favorable circumstances, a single bacterium can divide to form two within half an hour, and if this rate were continued for twenty-four hours, the original germ would produce over two hundred and seventy trillion descendants.

Such a maximum possibility is probably never realized under ordinary circumstances. However, the growth of the bacteria which you planted will be rapid enough so that in two or three days each one will have formed a considerable colony, appearing on the agar surface as a small spot, which may be yellow, white, red, etc., according to the color of the particular kind of bacterium.

In Figures 1 and 2 there are shown dishes photographed several days after exposure to different objects in regular classes in hygiene in Haaren High School. The human hair (Fig. 1, a) seems always to be favorable for the collection of bacteria. Plant a hair on agar, and you will generally find developing a continuous line of colonies, often salmon colored. Finger-nail dirt is also rich in bacteria. In figure 2, a, the nail exposure was made by jabbing into the agar the point of the knife which had just been used for manicuring. The very large dark gray colony represents the growth of a single mold spore with its radiating threads. The finger-tip culture (Fig. 1, c) gives a good crop, as might be expected; also the sputum (Fig. 2, b). A test of ordinary blackboard chalk (Fig. 1, b), made by scraping a freshly exposed surface of chalk into a petri dish, gave an interesting result: numerous colonies developed, all were uniformly yellow, and apparently all the same sort, probably from one of the pus bacteria (*Streptococcus*).

What Effect Do Antiseptics Have on Bacteria?

The importance of immediate first aid treatment for cuts, etc., and the relative value of different antiseptics can be easily discovered by each pupil for himself with the help of a few petri dishes. For example, in a profusely infected agar plate, cover a definite area with some iodine, and set aside. When the developmental period is over,

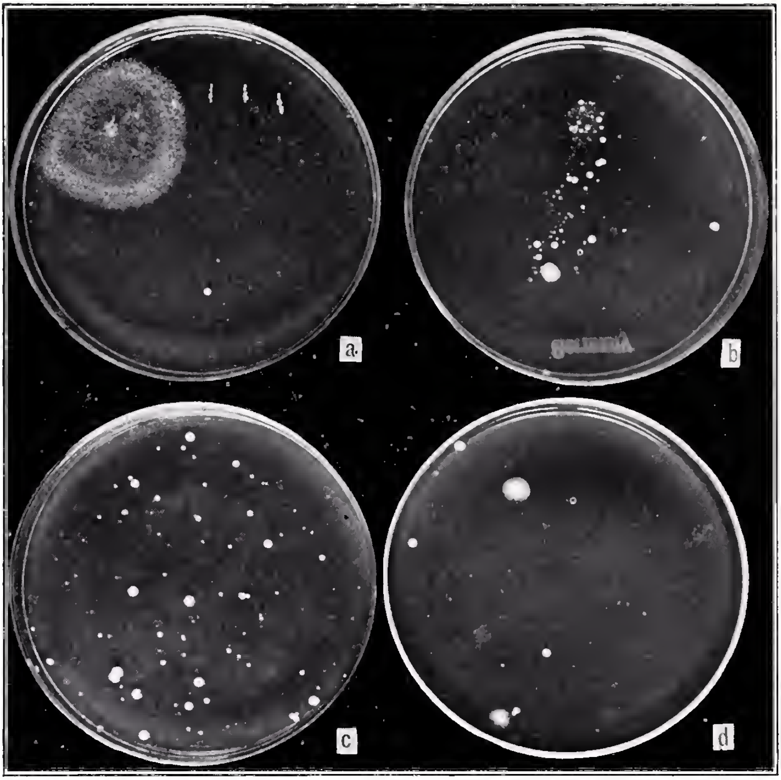


FIGURE 2. Bacterial colonies. *a,* from dirt from finger nails. *b,* from sputum. *c,* from air in hall when classes are passing. *d,* from air of quiet schoolroom.

let the pupils tell why colonies have not developed where the iodine was placed. Try the same experiment in other dishes with mercurochrome, common salt, boric acid, and other common antiseptics. It will scarcely be necessary for the teacher to contribute any word of explanation or authority.

Are There Many Bacteria in the Air?

If a petri dish plate is exposed to the quiet air of an ordinary classroom for a few minutes, and then put away for a developmental period, it will usually show finally a rather small number of colonies, indicating that the classroom air was relatively free from bacteria. (See Figure 2, d.) All forms of dust, including bacteria, tend to settle out of the air when it is undisturbed. If, however, another dish is exposed in a school hall when classes are passing, the developed plate will show several times as many colonies as the classroom exposure. (Figure 2, c.) Furthermore, if a dish is exposed to vigorous sweeping, or if dust is deliberately blown into it, the surface of the agar will be almost completely covered with colonies, so crowded that none can grow beyond a small size.

Such an experiment in the quantitative testing of the air under different conditions is always a convincing argument in biology or hygiene classes against the feather duster or dry-broom methods of house cleaning, especially when it is noted that pus bacteria are always abundant in such dust cultures. In class, the pupils are always anxious to test a great variety of objects and air conditions. The relative purity of park and country air is impressively demonstrated when petri plates exposed in these regions show a light crop of bacterial colonies.

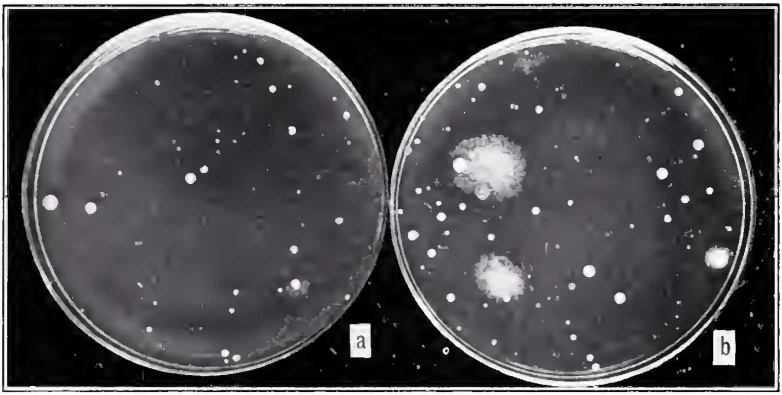


FIGURE 3. Bacterial colonies. *a*, exposed five minutes in subway station. *b*, exposed five minutes in subway train.

A test of the subway air is generally called for, and it is always surprising to find that the subway exposures show fewer colonies than exposures made in school rooms during the movement of classes. This is probably due largely to the fact that the subway is damp enough so that the dust does not fly around so readily. In Figure 3 are shown two plates exposed to subway air. The one opened in the train (a) shows many more colonies than the other (b) exposed in the station, probably because the cars contain much more dry dust, which is continually stirred up by the movement of the passengers.

Are There Many Bacteria in Milk?

Some years ago, in a class in bacteriology at Columbia University, one of the routine class experiments was the determination of the number of bacteria in samples of milk and of sewage. The average results of the tests seemed at first very surprising, for it gave a count of forty-eight million of bacteria per cubic centimeter, compared with

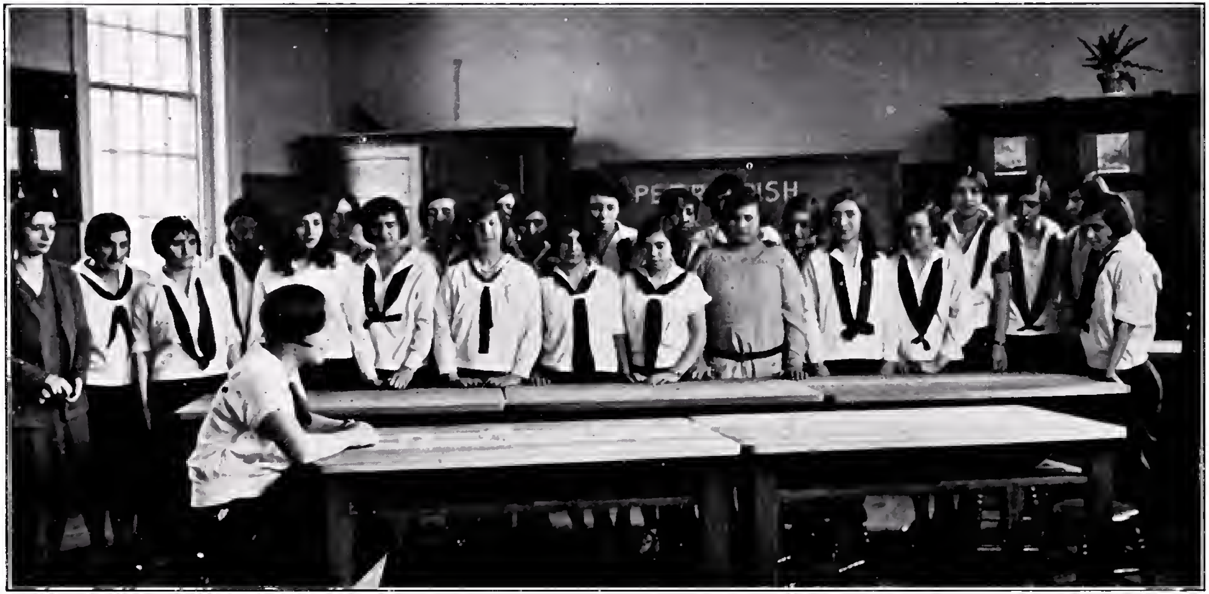


FIGURE 4. Classroom experiment in Haaren High School, New York City, to show the effect of a cough in carrying bacteria. Pupil at table, who has coughed vigorously, has petri dishes exposed at equal distances apart on the tables in front of her.

twelve millions for the sewage. Actually, however, the results were to be expected. At that time, pasteurization was not required, and the milk sample was taken from a large can to which dust and flies had frequent and ready access. The milk had probably not been quickly cooled after milking, and had been liable to contamination for twenty-four hours or more. Furthermore, the nutrient content of milk is ideal for most bacteria.

Within recent years, the pasteurization requirement for all but certified milk, and the strict sanitary supervision of its preparation and transportation from the farm to the consumer have reduced the bacterial count nearly a thousand times. At present, three grades of milk may be sold in New York City: Certified raw milk, which must contain not more than ten thousand bacteria per cc. when delivered to customers; Pasteurized, Grade A, for which the maximum number allowed is thirty thousand, and Pasteurized, Grade B, for which the number of bacteria is one hundred thousand at present.

How Far Does a Cough Carry Bacteria?

It is always interesting to demonstrate the method by which the danger range of a cough or sneeze may be determined. In Figure 4, there is shown the operation of such a demonstration before a Haaren High School hygiene class. On this occasion, five petri dishes were placed at intervals of one foot apart along the table. The pupil sitting at the end of the table has just coughed vigorously. The limit of safety in front of such a cough will be determined by the greatest range of bacteria expelled as mouth spray during the cough and developing as colonies in the petri dishes.

Such a classroom performance of this experiment is not likely to be very conclusive in its results, but the demonstration of the method is a vivid means of impressing the dangers of mouth spray, and the importance of observing simple precautions.

In general, with simple experiments like those described above, bacteria come to mean something definite to the pupils of science classes. They cease to be merely something disagreeable, unpleasantly suggestive of diseases, but indefinitely dangerous. Rather they are brought into the realm of examined and understood facts, to be dealt with according to their particular nature. Two petri dish lessons will cover experimentally all that has been suggested above and will be worth infinitely more than any quantity of didactic exposition.

In this connection, the following statement, from a recent issue of *Science* (Vol. 57, No. 1729, p. XII. 1928) is significant:

> The healthiest year in history was 1927. Only 8.4 deaths for every 1,000 persons is the record for a group of insured wage-workers that numbers one seventh of the total population of the United States and Canada.
>
> If the death rate of 1926 had prevailed, 8,808 persons among the insured group now living would have died, and

if the rest of the population improved its health as much, some 50,000 lives were saved. If the death rate of 16 years ago, 1911, had not been reduced 33 per cent to the present figure, last year's death list would have numbered 72,570 more among the insured group.

Although no actual proof is at hand, it is reasonable to conclude that this continual decrease in the death rate can be at least partly accounted for by the rapidly increasing knowledge and understanding of the habits of these microscopic organisms—death-dealing as well as useful. Their study now forms, practically universally, an integral part of our secondary education.

R. C. Benedict.

NOTICES

The Garden is open free to the public daily, from 8 a. m. until dark; on Sundays and holidays from 10 a. m. until dark. The Laboratory Building, containing the library, herbarium, and offices, is open daily (except Sundays), from 9 a. m. until 5 p. m. (Saturdays, 9-12). The Conservatories are open April 1-September 30, 10 a. m.-4:30 p. m. (Sundays, 2-4:30); October 1-March 31, 10 a. m.-4 p. m. (Sunday, 2-4).

To Reach the Garden take Broadway (B.-M.T.) Subway to Prospect Park Station; Interborough Subway to Eastern Parkway-Brooklyn Museum Station; Flatbush Avenue trolley to Empire Boulevard; Franklin Avenue, Lorimer Street, and Tompkins Avenue trolleys to Washington Avenue; St. John's Place trolley to Sterling Place and Washington Avenue; Union Street and Vanderbilt Avenue trolleys to Prospect Park Plaza and Union Street.

Entrances— On Flatbush Avenue (1) near Empire Boulevard, and (2) near Mt. Prospect Reservoir; on Washington Avenue, (3) south of Eastern Parkway, and (4) near Empire Boulevard; on Eastern Parkway, (5) west of the Museum building.

The street entrance to the Laboratory Building is at 1000 Washington Avenue, between Eastern Parkway and Empire Boulevard and opposite Montgomery Street.

The Leaflets are published weekly or biweekly from April to June, and September to November, inclusive, by The Brooklyn Botanic Garden, 1000 Washington Avenue, Brooklyn, N. Y.

Telephone: 6173 Prospect. Mail address: 1000 Washington Avenue, Brooklyn Botanic Garden, Brooklyn, N. Y.

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XVI BROOKLYN, N. Y., MAY 16, 1928 NO. 4

HOW SHALL WE SAVE RARE PLANT SPECIES FROM EXTINCTION

Does the plight of rare wild flowers and ferns appeal to you? Do you believe that we should try to preserve from complete extinction those rare native plants whose few natural habitats are being increasingly threatened by civilization: as when some industry demands the rock substratum in which they may live; or when some recreational park development, with its path systems and increasing crowds, denies them the undisturbed soil they must have? Do you believe that an intelligent consideration for the future demands that native plant species shall be accorded a place in the conservation program along with native birds, fish, and other animals?

In the case of our native birds, we awoke too late to the problem to save a number of species, notably the passenger pigeon. We were almost too late to save the American bison. That this is still a living and not an extinct species is largely due to its partial domestication in the sanctuary of public parks and its subsequent re-establishment in a few protected natural habitats.

As a matter of fact, the conservation of animal species has been immensely aided by support from two sources not scientifically interested in conservation. The whole fraternity of sportsmen have exerted a strong influence in favor of the game species of animals and the conservation of native songbirds has had the strong economic basis of their vital necessity to agriculture.

Despite, however, the fact that with plants we cannot start with such powerful support, the program for their conservation seems to be paralleling, to a considerable degree, the earlier campaign in behalf of animals. Thirty years ago, the boy interested in nature was encouraged to make collections of birds' nests and eggs. Then the importance of bird protection began to be recognized and this led to legislation establishing closed seasons for game birds and protected lists for songbirds. For game species many states have gone further in providing for the artificial propagation of threatened species, and the re-stocking of natural habitats. As population increased, and agricultural development gradually pre-empted the necessary native habitats, the next step was the establishment of sanctuaries, tracts of suitable land, where favored species are protected both from hunters and from their natural predatory enemies.

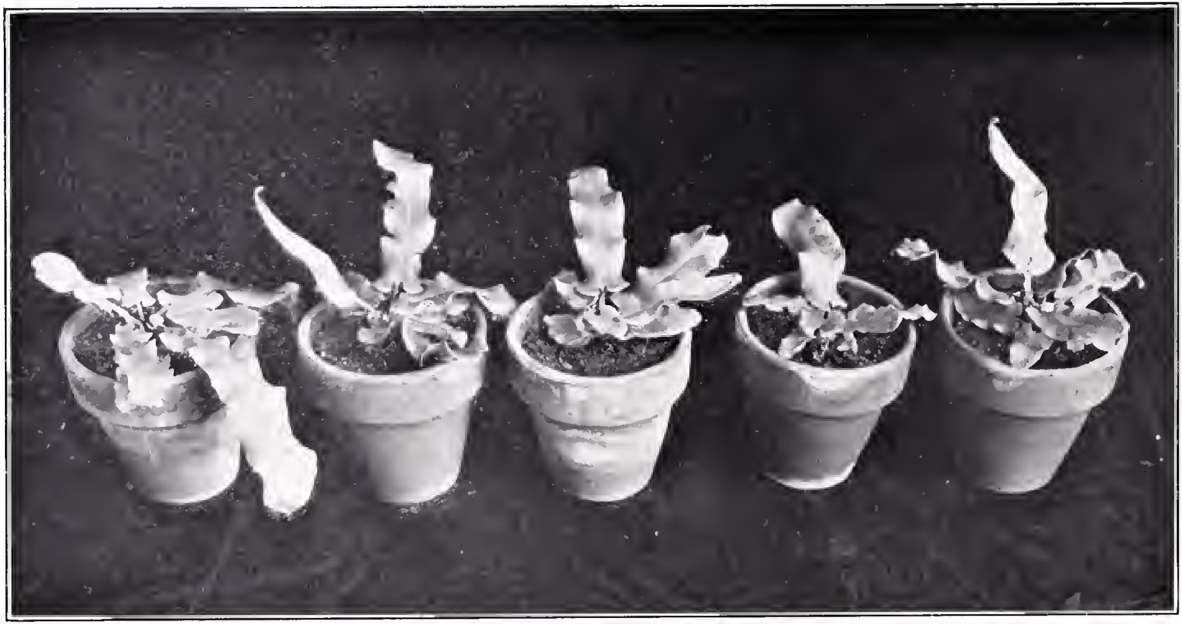


Fig. 1. "Fingerling" hart's tongue ferns; a few of several hundred sent out from the Brooklyn Botanic Garden to prevent the extinction of this rare species.

Artificial Propagation and Re-stocking of Native Plants

This leaflet is particularly concerned with the application of re-stocking and sanctuary measures to the conservation of plants. The principle of legal protection has already been accorded them in some twelve states. For example, New York lists trailing arbutus, laurel, pink lady slipper, and dogwood, as entitled to special consideration in its Conservation Law. Connecticut and New Jersey have passed laws of more general import, by which the primacy of the land-owner is more definitely recognized over the wild plant species of his woods and fields. We may hope that legal protection for plants will be recognized in all states before long, and that educational measures will be increasingly effective in creating a proper public opinion on this subject. In the meantime more immediate measures must be taken if we are to preserve those species most in danger of extinction.

As a demonstration of a practical method, applied to a species very definitely threatened by industrial and State Park projects, some hundreds of young plants of the hart's tongue fern have been raised at the Brooklyn Botanic Garden. These have been sent out widely to those who would undertake to give natural surroundings where they might become naturalized. It is still too soon to judge the success of this particular re-stocking experiment, but it is scarcely possible to doubt that this method can be successfully followed with a great majority of the threatened species. It would be particularly helpful if state experiment stations and agricultural colleges would adopt this method in favor of state flowers and any other species needing protection. Such measures, together with the improvement of legal enactments, will furnish the best bases for the education of the public to a point where formal restrictive measures may be superseded.

Plant Sanctuaries

Sanctuaries are needed for rare plants even more than for animals, since the animal can make an effort to find another location when threatened. Again the hart's tongue fern may be used as illustration. Known in the whole of North America only from two states and one Canadian locality, its three best localities are in Central New York, and in all three it has suffered severe losses.

The second illustration shows one of these localities at Green Lake, east of Jamesville, as it looked before the baking-soda industry acquired it as a source of limestone. Since then, the cliffs have been stripped of trees, now replaced by sheds, derricks, and rock piles. Within the field of this picture there were formerly probably the largest number of hart's tongue plants in any similar area. Just before quarrying operations had destroyed all of them, local fern lovers transplanted most of the ferns to other possibly favorable sites. With these plants, as with the small plants sent out by the Brooklyn Botanic Garden, it is hoped that private interest may succeed in preserving this species, despite the loss of its original locations.

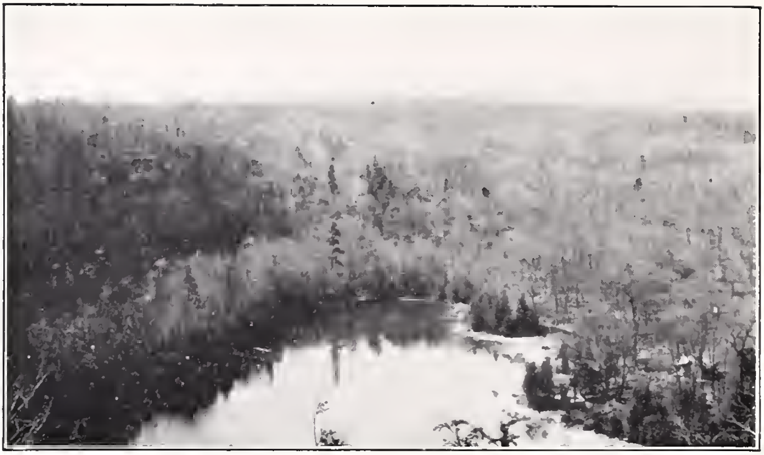


FIG. 2. Green Lake, east of Jamesville, N. Y., once a fine locality for the hart's tongue fern but now the site of extensive quarrying operations.

It might seem that State reservations would help in preserving rare plants, but the development of two recent areas in New York indicates the contrary. When the Green Lake, west of Jamesville was set aside as the Clark Reservation, nearby residents felt an increased right to carry away ferns for back yard gardens. Fortunately the hart's tongue grows there in rather inaccessible places, and to the uninitiated, is rather un-fernlike. However, after reading a recent news note regarding the plans for automobile roads and walks through the Reservation, the eventual destruction of this rare plant here seems inevitable. At Chittenango Falls, another recently added State Reservation, and also a fine hart's tongue locality, the State itself has been responsible for destroying most of the fine colony of this fern in the development of the path system.

Only the largest forest reserves constitute safe hiding places and then only through their inaccessibility. For practical conservation, private initiative must take the lead in setting aside tracts of land as sanctuaries where the propagation of rare plants and their naturalization can be carried out.

R. C. BENEDICT.

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Other leaflets on plant conservation will be gladly sent on request.

Telephone: 6173 Prospect. Mail address: Brooklyn Botanic Garden, Brooklyn, N. Y.

Brooklyn Botanic Garden

DEPARTMENT OF ELEMENTARY INSTRUCTION

A SURVEY OF WORK FROM 1913 TO 1928

On October 1, 1913, a wing of the present Laboratory Building of the Brooklyn Botanic Garden was ready for occupancy. Prior to that time certain general lines of educational work were laid down by the Director of the Garden and the Curator of Public Instruction. It might be interesting to note here, that few changes have been made in the general policy of the work, showing the clear sighted vision of these pioneers. An assistant, under the title of instructor, was chosen. That instructor became later the present Curator of Elementary Instruction. It was not in the original plan to divide the Department of Education into two heads, as it now is, but it was arranged that all the work should be done under one head. The rapid growth of the work with children was the determining factor in creating a second department, called the Department of Elementary Instruction.

In October, 1913, one room, now the Children's Club Room, was set aside for educational purposes. In this room the instructor had her desk, and here all classes and lectures were held. When two classes were meeting at one time, the library, now a classroom, was brought into service. At the present time there are three rooms set aside for class work; an auditorium which seats five hundred and seventy-five; the children's club room; an exhibit room; three greenhouses for instruction; the children's garden house in connection with the children's garden, with a piece of land covering approximately three-quarters of an acre. Added to the equipment for work are two stereopticon lanterns, one motion picture machine, stereoscopes and pictures, nature study material in the form of pictures and mounts, lantern slides, motion picture reels, microscopes, and an abundance of living plant material. The work in the Department of Elementary Instruction may be considered under the following heads:

1. Visiting classes.
2. Saturday morning classes for children.
3. The outdoor garden for children.
4. Teachers' classes.
5. Seed distribution.
6. Plant and nature study material supplied to schools.

I. Visiting Classes

On October 6, 1913, a class from Girls' High School came to our building for instruction in the planting of bulbs. This was the begin-

BROOKLYN BOTANIC GARDEN LEAFLETS

Series XVI Brooklyn, N.Y., June 2, 1928 Nos. 5-7

ning of visiting-class work in our new building. Before this time, beginning in October, 1910, the Director of the Garden held what would be termed the first visiting class, and from 1910 to 1913 there were occasional classes of high school students receiving instruction from the Director and from the Curator of Public Instruction. From that group of seventeen young girls on October 6, 1913, our work with visiting classes has grown, as shown by the following figure from our 1927 yearly report—the attendance at visiting classes being for this past year 35,378.

Twice a year, spring and fall, an announcement of lessons, lectures and field trips for visiting classes is sent out to all the elementary and junior high schools of the Borough of Brooklyn. Added to this list, by request, are the names of some of our private schools. Parochial schools are always welcome. The following lists show the type of work done at the Garden.

WALKS AND TALKS FOR ELEMENTARY SCHOOL CLASSES

October 3 to December 19, 1927

To Be Given at the Botanic Garden

GRADES 4A AND 4B	1.	Potted plants; names, care and decorative value. (Slides and plants.)
	2.	Fall Wild Flowers. (Specimens and slides.)
	3.	Simple classroom experiments with living plants. (Demonstration.)
	4.	How nature disperses her seed. (Demonstration material.)
GRADES 5A AND 5B	5.	The function of a flower. (Demonstration.)
	6.	Common trees and their value to man. (Demonstration, material and slides.)
	7.	How to start a nature collection. (Each student to bring a ½ lb. candy box.)
	8.	Four common ferns for classroom decoration. (Specimens.)
GRADES 6A AND 6B	9.	Bulb Culture. (Demonstration.)
	10.	South American Plant Products—Coffee and Rubber. (Motion pictures.)
GRADES 7A AND 7B	11.	Forestry. (Slides.)
	12.	Commercial Plant Products.

SPECIAL LECTURES FOR ALL GRADES

13. The Thanksgiving Festival—How nature provides for our dinner. (Specimens.)
14. Christmas greens—fir—holly—mistletoe. (Specimens.)
15. Nature Trail. (One class only. Notebooks and pencils should be brought.)

LESSONS, LECTURES AND FIELD TRIPS ON NATURE STUDY, GEOGRAPHY AND GARDENING

March 5 to June 15, 1928

To Be Given at the Botanic Garden

Grades 4A and 4B

1. Spring wild flower friends every child should know. (Lantern slides.)
2. The outdoor garden—what to plant and how to plant. (Lantern slides and demonstrations.)
3. Plants for classrooms. (Specimens.)
4. Soil—how it is made. (Experiments.)
5. The schoolroom aquarium. (Living materials.)
6. Penny packets of seeds—how to start them in your classroom or at home. (Greenhouse work.)

Grades 5A and 5B

7. Familiar tree families.
8. Rice—the food of a billion people. (Lantern slides.)
9. Function of flowers—what a flower means. (Specimens and field work.)
10. Beverage plants—tea, coffee, cocoa. (Lantern slides, living specimens.)
11. The story of cotton. (Lantern slides, specimens.)
12. Paper making. (Slides and materials.)
13. California and its oranges. (Motion pictures.)
14. Wheat and the middle West. (Slides.)

Grades 6A and 6B

15. Brazil and coffee culture. (Slides.)
16. The Amazon Valley and the rubber industry. (Slides and motion pictures.)
17. World commerce. (Slides.)
18. The cacao industry. (Slides and motion pictures.)

Junior High

19. Plant ecology. (Field work.)
20. The story of plant life. (Slides.)
21. Special spring walk about the Garden, with points of interest brought out.

NOTE.—Principals and teachers should make appointments for classes at least one week in advance. Cards for this may be obtained by writing to Miss Ellen Eddy Shaw, Curator of Elementary Instruction, Brooklyn Botanic Garden.

The list of talks is sent out with the following form card:

School........................Grade..........No. of Pupils..........
Address ....
Date..................................
The Curator of Elementary Instruction
BROOKLYN BOTANIC GARDEN

I wish to bring my class, as indicated above, to The Botanic Garden on date..........................at hour........................for purpose checked below:

1. *Talk No............for Elementary School Classes.*
2. *A special talk on...*
3. *Special work in the plant houses.*
4. *Visit the conservatories under guidance.*
5. *Visit the out-of-doors collections under guidance.*
6. *Visit the Japanese Garden.*

School telephone ....Teacher
(Additional copies of this card may be had on application)

Principals send for these form cards, and the number requested is sent back to the school. The individual teacher fills in the card for the talk, walk, or demonstration desired, and the time and date for the visit. If this fits in with the Department's program, a card is sent back to the school to confirm this, or to suggest other dates. In this work a wealth of material is used; living plants, models, the economic greenhouses, and the plantations. Syllabi on the following subjects have been published, so that visiting classes may take back to school, for further study, definite information in concrete form:

1. Rubber
2. Coffee
3. Tea
4. Little Gardens
5. Bulbs for Class Room Work.
6. Chocolate and Cocoa
7. Cotton
8. Rice
9. Sugar

In order that the grounds may become familiar to the children, and points of interest brought to their minds, a "guide-sheet" is made out monthly. In the classroom the guide-sheet is explained, and then, as the children go about the grounds with a guide, each child may check up on plants observed and points of interest brought to his attention. The following is a specimen of a Guide Sheet.

A Spring Walk.

Leave the main entrance of the Laboratory Building and turn left past the lily pools. Walk around the pools and take the path to the right. Look in the grass on your left and see the tulips coming up. You will pass the Chinese cherry tree in bloom. What color are its blossoms? As you walk along you will notice the daffodils just coming out. They are among the first flowers to bloom in the spring. Do you know any flowers that bloom earlier than daffodils?

Next you come to the Magnolia Triangle. Notice the big blossoms and the large furry buds on these trees. As you walk around the magnolia triangle look at the hillside on your left. It looks like a field of gold or sunlight. Think how many daffodils there are there. As you walk toward the Japanese Garden notice the Forsythia bushes in bloom. Do you think these blossoms are the same color as the daffodils?

You have come to the Japanese Garden. See if you can locate the following things in the Japanese Garden:

1. Torii.
2. Tea House.
3. The cherry tree on your left as you enter the Japanese Garden. See its red, shiny bark. Have its buds begun to turn pink yet?
4. Fagot fence.
5. Japanese iris coming up on the right hand side of the little path.
6. Water falls.
7. Moonview House.
8. Shrine on the hill. Can you find the sacred foxes guarding the shrine?

Leave the Japanese Garden and turn right, around the lake. Keep to this path back to the Magnolia Triangle, and after taking the path across the bridge, turn left. As you walk towards the Rock Garden see if you can find some tiny yellow Tulips on your left. As you pass the rock garden look at the little blue Hyacinths among the rocks on the left.

After you have passed the rock garden, look around you to see the willows growing along the brook. That is where willows like best to grow. See how light and yellow their tops are. Look at the other trees and notice the different colors of their new leaves.

A number of times each season, invitations are sent to a given number of schools to come to some special motion picture, such as "Rubber Gathering in South America," "Forestry in Switzerland," or "Cotton in our Southland." The Brooklyn Botanic Garden believes that the effort of bringing city classes to a public institution places an obligation upon the institution to provide excellent instruction, concrete data, and pleasurable experiences for the children and teachers. All visiting classes receive plants for their classrooms, in order that they may become acquainted with different types of plants and associate them with a visit to the Botanic Garden. A definite attempt has been made to encourage the attendance of small-sized groups rather than to pack the auditorium. It is believed that the impression made upon the child is deeper, and the instruction more worth while when given to smaller groups. During the last few years a number of Brooklyn schools, including some of the private schools, have requested series of five lessons given to a class, rather than different classes coming each week for the same period.

2. Saturday Classes for Children

On December 17, 1913, the first children's Saturday classes were started. Twelve children in the neighborhood of the Brooklyn Botanic Garden requested a class. During the year of 1927, fourteen years since the first class for children was formed, the registration in our regular garden classes was 4,405, with an attendance of 38,196. This figure includes not only the children's classes, but our classes for teachers, given under the auspices of the Brooklyn Teachers' Association.

The children's classes now fall into three yearly series. Spring classes begin in February and extend until the first of May. The general theme of these spring Saturday morning classes is preparation for the outdoor garden. Class rooms and greenhouses are used. The children make garden plans, start seedlings, test soil, germinate seeds, and become acquainted with the flower and vegetable seeds they are to use later in the outdoor garden. Any child with special ability along this line of work is eligible for Saturday morning classes. A fee of fifteen cents is charged, so that the children may feel a greater responsibility toward their work.

From the first of May until the middle of October the children's outdoor garden represents the second in our series of courses for children. A fee of twenty-five cents covers the cost of the seeds used in individual plots.

From the middle of October until Christmas, the third series of lessons is given. The theme of this work is indoor plant culture with some thought of Christmas and garden Christmas presents. The registration in these Saturday morning classes varies from 185 to 230, the outdoor garden ordinarily accommodating 230. During the war years there was a larger registration. These series of courses for children form a little school of education.

3. The Outdoor Garden for Children

The outdoor garden for children is a part of the above series of work for children, but looms so large that it might be considered by itself. In 1914 the first children's garden was laid out. This was on the land which is now occupied by the main part of our building. The strip of land upon which the children's greenhouses are built was given over to children's garden purposes, and here we had a practice garden for Pratt Institute senior and junior kindergarten students, taught by the present curator. The strip of land running along the Washington Avenue side, in front of the building, was also used, and upon this land the first garden-teachers' class had its practice gardens. During the war years the space directly in front of the building, facing the grounds, which is now a grass-plot, was used for war gardens and for demonstration purposes for instructing school teachers who were working with children of the Borough in war-garden work. The portion of land now occupied by experimental work was given over in part to war gardens for children and adults. At the close of the war, the children's garden was confined to the area now used and originally planned for it.

Within the privet hedge surrounding the children's garden are many features for study: such as plantings of common shrubs desirable to have in Brooklyn yards and upon school grounds; a perennial border of constant bloom, from early spring to late fall; a rose garden; a Shakespeare garden; a "picking border" of annual flowers; experimental plots for children's silver pin work; and individual vegetable garden plots. The arrangement, plan, and plantings have all been worked out with a definite idea in mind, the thought of enriching the life of the children of this Borough. Membership in this children's garden includes boys and girls from all over the Borough. The garden is not a neighborhood affair. A fee of twenty-five cents is paid. Each child has his own plot for vegetable raising; and works upon and enjoys the flower area in common with all the other children. During the summer of 1927 the following crops were taken out of the individual vegetable gardens:

Beans	370	lbs.	Lettuce	4728	heads
Beets	4097		Onions	10	lbs.
Beet tops	39	lbs.	Parsley	275	bunches
Carrots	3175		Radishes	18,079	
Celery	7	bunches	Spinach	83	lbs.
Chard	868½	lbs.	Tomatoes	130¼	
Corn	337	ears	Turnips	437	
Kohlrabi	3590				

Notebooks are kept, garden plans made, games worked out, so that this garden for children is not only a matter of work and study, but of enjoyment as well.

4. Teachers' Classes

A series of courses for teachers in children's garden work constitutes a unit leading to a certificate in children's gardening, recognized by the Board of Education of the City of New York. These courses are now given in co-operation with the Brooklyn Teachers' Association and are recognized for college credit by the colleges. In January, 1914, this work was started with a class of seven young women. In 1914 the class registration, including the classes for children's garden work and other classes, was 266 against 4,405 in 1927.

At the present time all the courses for the certificate in teachers' gardening, with the exception of Botany, are given under the auspices of the Department of Elementary Instruction. On October 29, 1913, a short course on house plants was started for the general public, with a registration of sixty people. Short courses in nature study and greenhouse work are given in the fall and spring. These courses are leaders for our longer courses. Growing out of this work come many requests from schools and clubs for speakers. On October 14 ,1913, our first request of this nature came from the Bethany Settlement, for a talk to the mothers, concerning the importance of nature and garden work for children. During 1927 the Department of Elementary Instruction gave one hundred and one talks.

Regular weekly class work has been given at the Brooklyn Botanic Garden to the following institutions as a part of their regular scheduled work and course of study for their teachers in training: Pratt Kindergarten Department; Maxwell Training School; Montessori Kindergarten School; Froebel Academy; New York Kindergarten School. These courses have extended over periods of a half year's duration and, in the case of most of the above mentioned schools, a year's duration.

5. Seed Distribution

In the spring of 1914, 25,000 penny packets of seed were filled for distribution to the school children of the Borough of Brooklyn. These packets were filled by hand. The envelopes were hand-printed. Children and members in the courses for children's garden work assisted in this work. In 1927, 705,694 penny packets of seed were sold. A room is set aside, equipped for the purpose of seed filling and packing. Even to this day all the filling is done by hand, and for the most part is voluntary service from the children belonging to our classes. Last fall the Brooklyn Botanic Garden entered into an agreement with the School Garden Association of New York to supply seeds to all the boroughs of this city. It is too early to give any report of this work. It is still in the nature of an experiment. The original purpose of the seed filling was to come in touch with all the children's garden work in this Borough and to encourage it as far as possible. Growing out of this work there was held each fall an annual exhibit of flowers and vegetables raised by the children of the Borough of Brooklyn. Twelve annual exhibits were held, with prizes for meritorious work.

6. Distribution of Plants and Nature Study Material

During each year the Department of Elementary Instruction supplies class-rooms with plants for purposes of decoration and study; and also nature study material. During 1927, 25,247 plants were distributed in this way; and nature study material was supplied to 1,151 teachers for the instruction of 44,920 children.

ELLEN EDDY SHAW
Curator of Elementary Instruction.

SCHOOL NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XVI BROOKLYN, N. Y., OCTOBER 31, 1928 No. 8 - 9

BULB CULTURE*

Bulbs are easier to raise in class-rooms and at home and give more pleasure than perhaps anything else in the plant world. Still, one must follow certain directions for their potting and culture if success is to be sure.

In the first place, certain kinds of bulbs are easier to raise indoors than other kinds. These should always be chosen in work with young children. The narcissus group is the most satisfactory of all for this work. Choose such members as paper white narcissus, poeticus, Von Sion, jonquils and Chinese lilies. These last are usually the least satisfactory because their blooms blast when exposed to the slightest of draughts.

Hyacinths come next in choice. They fall into two general classes, the Dutch and Roman varieties. The Roman ones bloom earlier than the Dutch. If tulips are chosen, order the early blossoming ones; for on the slower growing varieties plant lice often develop. Crocuses do well indoors, especially when planted in masses. These, then, are the easiest to raise of all the bulbs for indoor work, and the ones most likely to give success.

Bulbs should be bought during September and October, for all potting ought to be over by the last of October. For this work with bulbs, have ready the bulbs, soil, sand, charcoal, broken crock, and the pots.

THE BULBS.—In the first place, order these of any good seedsman. If hyacinths be chosen, remember that the named varieties are more likely to give good results, but they are more expensive than the unnamed ones. If one cannot afford the named varieties, order by color, such as the blues, whites, etc. Be sure to choose firm, solid bulbs. These have more strength to do their work—more food supply stored up. For, within the heart of the bulb the flower itself is already formed, ready to push itself up and out into the world when conditions are right. So the strong bulbs are better fitted for their work than the weaker ones. Remember this, too: that Roman hyacinths bloom earlier than other hyacinths, requiring a shorter resting period. Those planted in October may be had for Christmas bloom.

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* A third reprint of Brooklyn Botanic Garden LEAFLETS, Series 1, No. 12.

SOIL.—The soil for bulb planting should not be too heavy. Heavy soil clings firmly together when moistened, due to clay in it. Light soil falls apart. If the soil seems to be a heavy one, lighten it with sand, adding about one-third sand to the amount required. Sand not only lightens soil, but it helps by carrying surplus water off. In very heavy soils, water may collect about the base of the bulbs. This causes decay. Free the potting soil from lumps and stones; if necessary, sift it.

POTS.—Bulbs may be planted in pots, pans or flats. Pans are low crocks. Flats are low boxes of about four inches in height. The bottom of a flat ought to have holes in it or spaces for drainage. Many bulbs can be planted in a single flat, just as closely together as possible. When the bulbs are almost ready to bloom they may be transplanted into separate pots. The number of pots to buy depends upon the number of bulbs. It is a matter of calculation. Bulbs need just enough space to grow in, without touching neighboring bulbs. Suppose the pot to be a five-inch one: allow two Dutch hyacinths to such a pot; three Roman ones; two Von Sion daffodils; two paper white narcissus; three poeticus; four jonquils; five tulips—or four if they be large ones; six to eight crocuses; and eight to ten freezias.

METHOD OF POTTING.—After all the materials are gathered together, proceed with the potting after this fashion. The hole in the bottom of the pot is for drainage and to allow air to enter and get at the roots. This is important, for roots must have air. To be sure, some air is bound up in the soil, but the roots need more than this. Hence, the hole in the bottom of the pot is for this purpose, and should never be tightly clogged up. Place a curved bit of broken crock over the hole, with concave surface toward the hole. This covering prevents the soil from trickling through, or the water from passing out too fast; but it does not prevent the entrance of air. More air enters than if a flat piece of crock is placed directly across the hole. After this, put about an inch of drainage material in the pot, but less than this should go in shallow pans and flats.

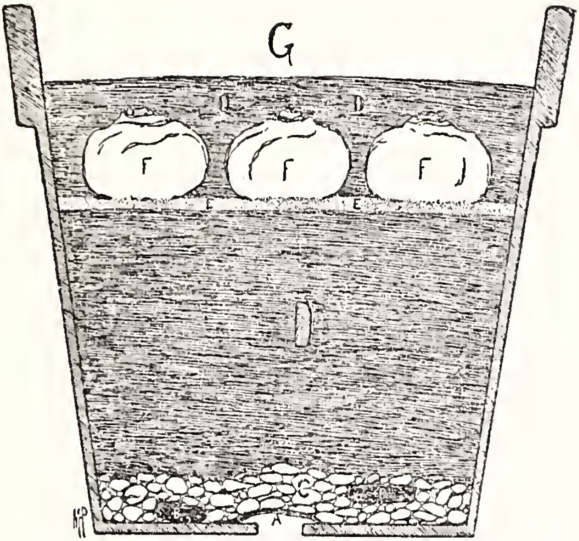

FIG. 5.—Longitudinal section of flower pot, showing arrangement of potting materials and bulbs. A, curved piece of crockery over drainage hole; B, charcoal; C, drainage material; D, soil; E, layer of sand; F, hyacinth bulbs; G, space for watering.

Materials to use for drainage purposes are crock, turf or sod, charcoal or even stone. These are spoken of as drainage material, because a loose area is formed through which water slowly trickles, and at the same time the soil is not clogged with too much water. Charcoal may serve a double purpose, for it is thought by some to sweeten the soil. It is perhaps well to use a piece of charcoal in each pot when other drainage material is not used. One can raise bulbs successfully, of course, without using charcoal at all. The soil goes next after this layer. Now comes another point to calculate, and that is the amount of soil necessary before putting in the bulbs. Find it out thus: hold the bulb to be used down into the pot so it is in the place it ought to be. Hyacinths should be potted so that their noses (the pointed end of the bulb is called the nose) are one-half inch below the surface of the soil; tulips, one-quarter inch below the surface; and the narcissus group above the soil. The upper surface of soil in a pot should be one inch below the edge of the pot. This space is allowed for watering, so that soil will not flood over the edge of the pot when water is put on. After this, put a little sand over the soil, a layer not more than an eighth of an inch thick. This sand bed acts as a drainage area, allowing water to trickle down and away from the bulb. Now place the bulbs in their sand beds. Leave just space enough between the bulbs so that no two touch. Neither should they touch the sides of the pot. Cover with soil, pressing it down firmly about the bulbs. Now they are ready for the season of rest.

Resting Period.—All potted bulbs should be placed in a dark, cold place for six to ten weeks. Roman hyacinths may be brought in after a month's rest. The object of this resting period is to give time for the roots to develop slowly and surely before the plants are brought into the light. For as soon as this time comes, a bulb expends all its energy in forcing the flowers and leaves, so the work of root making must be done before this time. If the roots are not properly developed, good results cannot be expected. The roots are properly developed when they begin to force their way out of the hole in the bottom of the pot. The pots may be stored for this resting period either indoors or outdoors. If they are to go indoors, select a cold, dark place, such as a cool cellar or basement. The bulbs must be watered once or twice a week. If they are to go outdoors, one of two methods may be employed. Either dig a trench in the ground for them; or prepare a box. If a trench is dug, it must be at least eighteen inches deep, and wide enough to take in the widest receptacles. Place two inches of coal ashes on the bottom of the trench. This layer assists drainage and offers an obstacle in the path of ascending worms. Now the pots of bulbs are placed on the ashes and soil put all about and above them. Fill in the rest of the trench with soil or coal ashes. Coal ashes form a looser layer than that made by soil, so it is easier to shovel off the ashes in cold weather. Never use wood ashes, because of the lye in them, which, trickling down to the bulbs would kill them. Leave them thus until you wish to take them in. But allow six weeks for development. Nature does the watering. The second method, that of using a box, is an excellent one for use in schools. Get a box of the size you wish; it should have a depth of at least two feet. Put an inch layer of sand, soil or ashes over the entire bottom of the box, placing the pots on this. Cover the pots in the box with sand and then fill the box full with coal ashes. In extreme weather put a covering over the box, which is left outdoors, on the ground or on a roof. Again nature does the watering. The box may be lined with a heavy wrapping paper, which insures greater warmth. Be sure to mark the pots with wax crayons. This is very essential in school work, so that children may receive their own pots.

CARE OF BULBS.—When the pots come out of the darkness, do not immediately bring them into direct sunshine. Let this be gradual, first leaving them in a darkened part of a room, and finally when the buds begin to open, see that they receive the direct sunlight. Water freely, for it helps the blossom to unfold. Never let a pot stand where a draught strikes the plant, or the blossoms will blast before unfolding. After the period of bloom is over, let the blossoms, leaves and all, completely wither up. Then cut the stalks back to one inch from the bulb itself. Shake all soil from the roots and place the bulbs in the sunshine to dry out. Pack away in tin boxes. These bulbs may be planted outdoors the following fall; they are of little or no value for further work indoors, for they rarely give satisfactory blossoms. Chinese lilies can never be used again after one period of blossoming.

WATER CULTURE.—Some bulbs will grow well in water, pebbles and water, or sand and water. Hyacinths do well in tall glasses which the florists and seedsmen sell for this purpose. Fill the glass with water, place the hyacinth in the top of the glass with the pointed end of the bulb up. Now place the glass away in a dark closet, but not necessarily a cold one, until the hyacinth's roots are way down to the bottom of the glass. Then it is time to bring it to the light. Chinese lilies and other members of the narcissus group may be planted in pebbles and water. The pebbles are placed in the bottom of the glass dish or earthen one. Upon this layer, place the bulbs, two to an eight ounce dish, and surround them with pebbles for the purpose of steadying the bulbs. Water should be poured in so that it just touches the base of each bulb. These dishes of bulbs ought to go into a dark closet until good root growth has developed. Paper white narcissus, Von Sions and poeticus may be buried in a bank of sand, but leave the noses of the bulbs sticking out of the sand. Treat these as you would those planted in pebbles and water, except that the entire sand mass must be always saturated with water.

OUTDOOR PLANTING.—An outdoor bulb bed is excellent for school grounds, being decorative and easy to plant. Tulips look well in round beds planted in one color masses. Border beds may be filled with daffodils or hyacinths. Crocuses, snowdrops, and little grape hyacinths are planted here and there in the grass. The single flowered varieties of bulbs are more attractive than the double flowering kinds. In preparing an outdoor bed be sure that the soil is dug up and made fine for a depth of eight inches. Different bulbs are planted at different depths. Hyacinths should go six inches beneath the soil and six inches apart; narcissus and tulips, four inches down and four apart; crocuses three inches deep and three apart; all small bulbs, like snowdrops, etc., should go only just beneath the surface of the soil. Cover the bulbs over with soil. When the weather becomes cold and just before frost, put about two inches of barnyard dressing (horse manure) over the beds. Later, as the weather grows colder, put a piece of sacking or heavy wrapping-paper over each bed. Hold these down with stones so that the wind does not blow the covers away. This last cover is not an absolute necessity. When the spring comes, take away whatever remains of the coverings and see the tips of the bulbs poking out of the ground. For outdoor planting, buy "bedding" varieties. Do not wait until late October or November to buy bulbs, for they lose value during the fall, shrinking and becoming less strong. The outdoor bulb bed may be left as it is after blossoming time. That is, the bulbs may be left in the ground, and the tops cut off. Of course, all the bulbs could be dug up, dried, and planted out again the next fall. These bulb beds should have new bulbs put in about once in four years.

ELLEN EDDY SHAW.

HARDY CHRYSANTHEMUMS

The hardy chrysanthemums always stage the last floral display of the season, and one involuntarily associates them with cool, frosty nights, brisk, sharp air, and all the signs of coming winter. As if to console us for such a doleful outlook, they are decked out in gayest hues, their colors being remarkable for their brilliancy.

The Garden collection south of the Rock Garden is just now (October 29) the object of great admiration. The named varieties are in a long bed close to the walk. At the rear of these comes "Araby"—creamy white with sometimes a touch of pink, alternating with plants of "Julia"—of an Indian-red shade. Next in front is a solidly double pink sort which, we think, is the prize one of the collection. The two rows in front are of different shades of yellow, the bright yellow of "Aurial" deepening to the golden yellow of the plants of "Quinola," which occupy the front row.

Judging from the many unopened buds, one may safely forecast that the exhibition will last at least two weeks longer. The three beds to the southward running at right angles to the walk contain a mixture of plants raised from seed, and with their variations of the color theme of red, white and yellow, and their solidly massed blooms, present as colorful a picture as any the Garden has to offer.

As to culture of the hardy chrysanthemums, there are various methods of handling them. In sections where they survive the winter out-of-doors, they are left where they are planted, and all that is necessary to keep them in good health is regular fertilizing, occasional division, and replanting.

Another method and that followed at the Brooklyn Botanic Garden in the case of named varieties is to dig up the old plants in the fall and store them in flats of soil in the cold frame until the middle of January. They are then brought into a cool greenhouse, which causes the production of young shoots at the base of the plant. When these shoots have attained a length of three inches, they are taken off and inserted as cuttings in a sand bed. When these cuttings are rooted, they are transplanted in soil in three-inch pots, which, as soon as the weather is suitable, are transferred to the cold frame. They are ready for planting about the middle of April out-of-doors where they are to bloom.

Still another method of raising these chrysanthemums is from seed. The seed should be planted about the middle of February in a seed pan of fine soil. When the seedlings have made their first true leaf, they are transplanted into flats, about two inches apart each way. From now on, they are treated the same as the cuttings except that it is not necessary to transfer them into pots.

When raising chrysanthemums from seed, one is not assured of the color, shape, or amount of doubleness of bloom that will be produced by the seedlings, and if one has a definite color scheme in mind, one is restricted to the use of named varieties, which are handled by means of cuttings and divisions as previously described.

Chrysanthemums delight in a rich, well drained soil. When the old plants are taken from the bed in the fall, the soil should receive a heavy dressing of partly decayed stable or barnyard manure, which should be immediately dug deeply into the soil. A few weeks after the young plants are set out in the spring, the bed should receive a surface dressing of bone meal, using it at the rate of 12 pounds to 400 square feet.

Montague Free.

NOTICES

The Garden may be reached in the following ways: Flatbush Avenue trolley to Empire Boulevard; Franklin Avenue and Lorimer Street trolleys to Flatbush Avenue; St. John's Pl. trolley to Sterling Place and Washington Avenue, Ninth Avenue Union Street, Vanderbilt Avenue, and Smith Street trolleys to Grand Army Plaza and Union Street; Brighton Beach Express, Broadway (B.M.T.) Subway to Prospect Park (north exit); Interborough Subway to Eastern Parkway-Brooklyn Museum Station.

The Garden is open free to the public daily, from 8 a. m. until dark; on Sundays and holidays from 10 a. m. until dark. The Laboratory Building, containing the library, herbarium, and offices, is open daily (except Sundays), from 9 a. m. until 5 p. m. (Saturdays, 9-12). The Conservatories are open April 1-September 30, 10 a. m.-4:30 p. m. (Sundays, 2-4:30); October 1-March 31, 10 a. m.-4 p. m. (Sunday, 2-4).

Entrances—On Flatbush Avenue (1) near Empire Boulevard, and (2) near Mt. Prospect Reservoir; on Washington Avenue, (3) south of Eastern Parkway, and (4) near Empire Boulevard; on Eastern Parkway, (5) west of the Museum building.

The street entrance to the Laboratory Building is at 1000 Washington Avenue, between Eastern Parkway and Empire Boulevard and opposite Montgomery Street.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

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PRACTICAL SUGGESTIONS FOR THE GROWING OF CHRISTMAS GREENS

In the Leaflet issued last year, entitled "What Price Christmas Greens?", the Brooklyn Botanic Garden put forward the suggestion that nurserymen, landowners, and any others interested, be encouraged to grow and market Christmas greens on a commercial scale. This was offered as a practical remedy—a way out of the present jeopardy in which the fast-disappearing wild plants used for Christmas greens find themselves.

In response to that leaflet, we have received during the past year many queries as to just how to go about this growing of Christmas greens. The present leaflet is intended as an answer to those queries. It has a twofold purpose: (1) to encourage the culture of wild plants used for Christmas greens, and thus lessen the danger of their extinction; and (2) to enable landowners to employ their idle land in a profitable way. Although our recommendations apply particularly to the region about New York City and to Long Island, they may be extended, with some modifications, to a much larger area.

The Growing of Christmas Trees

The subject of Christmas greens cleaves naturally into two parts: (1) Christmas trees; and (2) evergreens, berry-bearing shrubs, etc., used for Christmas decoration. Let us take the Christmas trees first. It should be emphasized at the start that the use of Christmas trees is not really a part of the problem of the conservation of ornamental Christmas greens. The Christmas tree is not a "problem" at all; it is a "legitimate by-product of the forest." Every year probably more than ten million Christmas trees are shipped from the forested areas to the distribution centers in our large cities—Red and White Spruce and Balsam Fir in the northeast, Engelmann Fir and White Fir in the Pacific Coast area, and Red Cedar and Pines in the south. The use of these young trees from the forest for this purpose brings a larger monetary return for their age than they would yield in any other way; and, if wisely cut, i.e., if selected here and there in the forest, their removal improves the prospects for the future growth of the trees remaining.

And yet it is possible and indeed a simple matter for those of us who own land, or enjoy the use of it, to grow Christmas trees either for our own use or on a large scale for the market. Of all the ways in which idle land may be employed, this probably involves the least expenditure of time and money.

As to the kind of trees to grow, unfortunately the much beloved Balsam Fir (*Abies balsamea*) does not thrive in this immediate neighborhood. Evidently it doesn't like our hot summers, and pines for its cool northern home. A little to the northward of us, however, especially in the Catskill region, it is being grown with very satisfactory results.

The Norway Spruce (*Picea Abies*). For various reasons we believe that for the region about New York City and especially Long Island, the Norway Spruce is the best adapted to Christmas tree requirements. A native of northern Europe, it is now, and has been from earliest times the Christmas tree of northern European countries; and for this purpose its symmetrical, cone-shaped form and gracefully pendent branchlets admirably lend themselves. The only disadvantage, Christmas-tree-wise, is that after the tree is cut, the needles are shed much sooner than they are in the Balsam Fir. It grows slowly at first, attaining, in this country, about two feet—sometimes more—in the first five or six years of its life. At this age it is suitable for a small Christmas tree. From then on it grows more rapidly, if conditions are favorable—it likes best a somewhat moist and deep loam—so that in 10 years from the seed it should be from 6 to 8 feet high and of good marketable Christmas-tree size. Under modern apartment house conditions, the sizes most in demand for Christmas trees range from 4 to 8 feet.

How to Obtain the Stock. For raising Christmas trees on a large scale, the best and cheapest way is to plant young seedlings two years old, or transplants three or four years old. If the young trees are to be planted in New York State, they may be obtained from the New York State Conservation Department, Albany, New York, at the rate of $2.00 a thousand for 2-year olds (seedlings), $4.00 for 3-year, and $5.00 for 4-year olds (transplants). Others are taken for not less than 1,000 trees, with an extra charge of $1.00 on all orders for less than 5,000. Order blanks may be obtained by addressing the Conservation Department.* If the planting is to be done outside New York State, it would be advisable to communicate with the forestry department of the state in question. Prospective planters are urged to get in their orders early.

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* The New York State Conservation Department have written us that they will "furnish spruce and balsam for planting for Christmas trees, and that the use of these trees for this purpose at any age will be permitted, provided the tree is severed from the root so that it is not resold as an ornamental tree."

Planting the Stock. The young trees grown in the nursery from seed are either sold as seedlings after one or two year's growth in the seed beds, or "lifted" after either one or two year's growth and transplanted to rows. The next year they may be transplanted a second time. This operation of transplanting produces more compact root systems and therefore transplants will make a quicker growth from the start. The young trees, whether seedlings or transplants, are known as the "stock." We do not advise prospective planters to raise their own stock, since this requires special training and experience, and, moreover, such stock can be obtained at very low prices from the State or from commercial nurseries.

For this locality, the best time for planting the stock is during the month of April, or as soon as the frost is out of the ground. Satisfactory results should be obtained if the stock is planted in open grass land. If the grass is of rank growth, we recommend the 4-year transplants as stock, since, under these conditions, smaller trees grow slowly at first, and are apt to be smothered. If the land is plowed in preparation for planting and kept under cultivation for a year or two, the growth should be somewhat more rapid, but it is rather doubtful whether the result will justify the additional labor. For the growing of Christmas trees the aim should be to produce a stocky tree with the branches fairly close together, rather than one in which the growth has been rapid, resulting in a long-drawn-out, spindly appearance.

When the stock is first received from the nursery, and up to the time it is planted, the greatest care should be taken that the roots do not dry out, by protecting them with wet burlap, sphagnum moss, etc. The stock should be planted as soon as possible after its arrival from the nursery and its roots should be thoroughly puddled just before planting, that is, dipped in a thick mud of such consistency that it will stick to them. But if the planting is done on a wet day or in moist air, the puddling may be omitted.

If, as often happens, the stock can not be immediately planted, it should be "heeled in." For this a trench is dug in moist soil, with one side sloping slightly from the vertical, and deep enough to accommodate all of the roots laid lengthwise, and most of the tops. The bundles of plants are then laid against the sloping side of the trench in a thin layer and fine soil worked in carefully about the roots and gradually filled in from the other side of the trench until most of the tops are covered, firming the soil gently with the feet. The place where the heeling in is done should be in the shade and when the stock is so treated it may be left for several weeks without injury.

If some of the young spruces are to be sold when 6 or 7 years of age, as small Christmas trees (3-5 feet high), it is suggested that the stock be set three feet apart each way. In two or three years from planting the alternate trees in the alternate rows as well as *all* the trees in the other rows may then be cut and sold, thus leaving the remaining trees six feet apart each way. These may be left until of a suitable size for the regular Christmas tree trade—perhaps from 10 years of age upward. At 10 years of age (or 6 years after planting for 4-year old transplants), the trees should be from 6 to 8 feet high.

This suggestion for a "working plan" is offered only tentatively, however. In practice it will probably be found that some of the trees grow much faster than the others because they happen to have better soil conditions, or had a better start to begin with. If the market warrants it, these larger trees may be thinned out, i.e., selected here and there, leaving more room for the others. But this is not necessary; the trees will crowd each other very little if left to grow undisturbed for at least 6 years after planting.

The best kind of a planting tool is the grub-hoe, unless the soil is stony, and then the pick-mattock can be used to advantage. One man should plant on an average of 500 to 600 young trees a day. To set out an acre of trees, the number required, if they are to be planted in rows 3 feet apart each way, is 4,840; if they are set 6 feet apart, 1,210.

The operation of planting, itself, is simple. The turf or surface growth is removed with the grub-hoe or the broad end of the pick-mattock. The soil is now loosened and a small hole dug slightly deeper than is necessary to accommodate the roots of the young tree (4 to 6 inches). The little tree is then placed erect in the hole, the soil filled in around it, and tramped down with the foot, the workman always taking care that the roots are not doubled up in the process and that the young stem is not sunken below the surface of the soil. The whole operation should take not over a minute, and in good loamy grass land, free from stones and other obstacles, somewhat less than this.* After once being planted no further care is needed—but *beware of fire.* It would be advisable to keep a margin from 10 to 20 feet plowed around the plantation or at least clear of all vegetation to avoid this greatest of all dangers. Some years ago fire completely destroyed in a few minutes several acres of a fine Norway Pine plantation belonging to the writer—trees 10 years old and about 10 feet high—which unfortunately were not thus protected.

Harvesting the Trees. Very little need be said about harvesting the trees for the market. They are easily cut with a saw, and before transportation to market should have the branches bent slightly upward and loosely tied. The propensity of the Spruce to drop its needles more quickly than does the Balsam Fir should be borne in mind, and harvesting and marketing on this account should be carried on as close to the Christmas season as is practicable.**

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* For further information on planting see TOUMEY, J. W. Seeding and planting in the practice of forestry. John Wiley & Sons: New York, 1916.

** A further point that should be mentioned in this connection is the alternative always open to the grower of Christmas trees to change his mind and let his trees (or some of them) continue to grow for timber.

The Douglas Spruce (*Pseudotsuga douglasii*). We recommend also the Douglas Spruce as a subject for Christmas tree propagation. A mighty tree of the great forests of the Northwest, it nevertheless accommodates itself with rare adaptability to our hot and often dry summers in the East, and its satisfactory growth in the heart of New York City is remarkable, for here it is often used as an ornamental evergreen to adorn the small grass borders of apartment houses. It assumes the symmetrical cone shaped form required of a Christmas tree, is a fairly rapid grower, and is free from disease. Mr. Henry Hicks, of Hicks Nurseries writes: "For living Christmas trees we have adopted the Douglas Spruce." The only objection to this species from our point of view is the higher cost of the stock as compared with Norway Spruce. This species is not distributed by the New York Conservation Department. So far as we know the lowest quotation is $25 a thousand for seedlings 3-6 inches high, and $100 a thousand for stock once transplanted—6-8 inches high.

Ornamental Evergreens

The Hollies (*Ilex sp.*). Of course the most attractive evergreens for Christmas decoration are the Hollies, and of these the English Holly (*Ilex aquifolium*) is the most pleasing. In the region about New York City, however, the English Holly is not quite hardy, often dying back in unfavorable winters. But the American Holly (*Ilex opaca*), is quite hardy in this locality. In its wild state it grows as far north as Massachusetts. Although rare in the immediate vicinity of New York City, it becomes increasingly more abundant as one goes southward in New Jersey. Its deciduous-leaved cousin, the Common Winterberry (*Ilex verticillata*) is, however, common in this neighborhood in wet ground and swamps, and its branches, laden with bright red berries which have much the same appearance as those of the American Holly, are much in use for Christmas decorations. Another species, the Inkberry (*Ilex glabra*), which grows wild on Long Island, deserves to be cultivated. Although its berries are inky black, the leaves are evergreen and lustrous and make a splendid combination with the red berried branches of the winterberry.

All of these American species of Holly can be grown for the market in this latitude, and given a fair amount of light and a good soil, should thrive in anyone's yard or garden. In milder situations south of New York, the English Holly can also be raised. Already a nursery firm in the Northwestern United States is plying a profitable trade in the raising and marketing of English Holly.*

Germination of the seed is slow, usually requiring two years from sowing, so that the most practical method of propagation is by cuttings.

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* The State College of Washington has recently issued the following bulletin which refers particularly to the English Holly. Locklin, H. D. Culture of Christmas Holly. pp. 1-25. 5 figs. Bull. 7-W. New Series. State College of Washington. Western Washington Experiment Station, Puyallup, Washington, 1928.

At the Boyce Thompson Institute for Plant Research, Yonkers, N. Y., experimental work on the rooting of cuttings of various plants has been going on for some time. As regards the rooting of Holly cuttings, the following directions have been kindly furnished us by Dr. P. W. Zimmerman of that institution. The directions apply particularly to the evergreen Hollies—the American Holly, the European Holly, the Chinese Holly (*Ilex cornuta*) and the Inkberry. The Winterberry may be treated similarly.

DIRECTIONS FOR ROOTING HOLLY CUTTINGS

"*Material to use*—Current year growth about 4 to 5 inches in length cut so that the two-year-old wood is just omitted. Two-year-old wood will root and in case current growth is too short include enough two-year-old wood to make desired length. Remove all but the upper two or three leaves. It is important that the leaves be green and healthy and that no spots are present; for there is a Holly leaf spot which if it gets a start causes the leaves to drop, and hinders successful results.

Medium for cuttings.—Bank sand mixed with peat moss,* approximately 50-50 by volume. Pure sand will also serve but we prefer the mixture because it holds water better, and does not require such frequent sprinkling. Be sure the peat moss is wet before planting cuttings.

Method of planting.—Lower cuttings so that the leaves will rest on the medium, thus preventing evaporation. A 45 degree slant will aid in placing the cuttings.

Temperature requirements.—60 to 75 degrees daily variation is satis-satisfactory. Even slightly higher and lower would not be fatal. Quicker rooting would probably be secured from constant 70° but it is unnecessary for practical purposes.

Time required.—Cuttings should be left in medium 3 to 4 months. Roots start after 5 to 6 weeks but rooted cuttings are not safe after being potted off unless they have a fairly large, hard root system. Cuttings may be left until spring and then lined out in rows.

Potting off.—Remove carefully from medium. Roots break easily. Pot in mixture of ¼ peat moss and ¾ soil. Place in very moist place for two weeks. If time to line out, plants may be placed directly in nursery rows but should be kept covered with cheesecloth for a week and also well watered.

Time for collecting holly.—Cuttings can be collected any time of the year excepting the middle of the summer when the growth is too succulent. Our best results have come from material taken from September to December before any frost injury comes to the leaves. Cuttings taken in September should have a cool treatment after they have rooted in order to permit of good growth in the spring. Dormant plants sometimes require a month or two of cool weather before they will grow well. Therefore if possible the greenhouse should be kept cool during the last month or two after the cuttings are rooted. While this is not absolutely necessary it will be found beneficial."

Dr. A. E. Hitchcock of the Boyce Thompson Institute states that from several years of experience he has "found that individual trees vary considerably in their ability to root from cuttings, also that rooting in sand is much slower than in a mixture of sand and peat moss. For good shoot growth or rooted cuttings it is important that the material be subjected to a cold period of approximately two months if cuttings are taken before the latter part of November."

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* This refers to the granulated peat moss that is now being imported, mainly from Europe for use by florists and gardeners, and for other purposes.

It is important in selecting the wood for the cuttings to choose mainly the berry-bearing individuals, since the Holly or Ilex is dioecious; i.e. some so-called sterile individuals produce pollen only, while other (fertile) plants bear the fruit. In order to be assured of a good crop of berries, however, one should have a few pollen-producing individuals in his plantation.

Also, in the case of the American Holly, in selecting the plants from which to make cuttings, it would probably be safer to use material which has been grown in local nurseries, or else occurs in a wild state in this region and has thus proved its hardiness; since it has been claimed that the individuals hailing from the south are not always hardy here.

Mountain Laurel. Last year, following the recommendation of the Marsh Botanical Garden,* we suggested that landowners treat an established stand of Mountain Laurel as a crop, cutting the branches every 4 or 5 years close to the roots and marketing the product.** In many cases, depending, of course, chiefly on the amount of laurel produced, this would probably afford a sufficient return to pay for the taxes on the land.

As to raising Mountain Laurel from seed, although this can easily be done by sowing the seed on screened sphagnum moss (not the imported granular kind) there are no data available, as far as we know, on the rate of growth of the plants and the time required until they reach a size suitable for marketing the branches. We cannot, therefore, make any recommendations, but suggest that it would be interesting to try it out on a small scale, experimentally.

Other Berry-Bearing and Ornamental Shrubs

Among other ornamental and berry-bearing plants which might be raised for the Christmas trade are the Japanese Barberry (*Berberis Thunbergi*), and the Japanese Yew. The Japanese Barberry is an attractive shrub with bright, slightly elongated berries which persist on the branches all winter. We have seen a very pleasing effect produced by combining the red berried branches of the Japanese Barberry with the dark green foliage of the Yew.

The silver-dollar-like remains of the seed pods of Honesty (*Lunaria annua*), an easily grown and often self-sown annual, a member of the Cress Family, are an attractive element in winter bouquets. All these, however, are offered merely as suggestions. Their culture as a commercial proposition should depend upon whether the demand is sufficient to warrant it, upon the time required for the plants (in the case of the shrubs) to reach a marketable size, and the total expense involved.

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* Buttrick, P. L. Connecticut's state flower, the mountain laurel, a forest plant. Marsh Bot. Gard. Publ. 1:1-28. 7 *figs.* 1924.

** Others have stated that by this method Mountain Laurel will "produce a good crop in from two to three years." Of course, in this matter, a good deal depends upon the quality of soil and the site.

ARTHUR HARMOUNT GRAVES.

RECENTLY PUBLISHED LEAFLETS RELATING TO THE CONSERVATION OF PLANTS

1. Graves, Arthur Harmount. Arbor Day. Series X. No. 1 pp. 1-4. 1922.
2. Benedict, R. C. Wild plant conservation in Connecticut, a suburban state. Series XI. No. 5 pp. 1-4. 1923.
3. ——. The conservation of beauty. Series XIII. No. 5-6. pp. 1-8. 1925. (Reprinted and enlarged from a former issue.)
4. Graves, Arthur Harmount. What price Christmas greens? Series XV. No. 11-12. pp. 1-8. 1927.
5. Benedict, R. C. How shall we save rare plant species from extinction? Series XVI. No. 4. pp. 1-4. 1928.

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